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THE GERMAN CHEMICAL MYTH

BY BENJAMIN T. BROOKS

"Germany leads the world in chemical industries, because her people are, upon the average, the most thoroughly educated and especially because her universities had developed the science of chemistry for decades before it was important in any other country."

This is not a quotation from German propaganda, but is found in a book published in 1913 and written by a well-known American economist. Is this a true statement of fact or not, and if *not,* then how does it come about that most of us have believed the facts to be substantially as the economist has stated them? This is worth a little inquiry, not so much on account of the importance of chemistry and its industries, but because it reflects a common state of mind. We have been ready to believe almost anything of German science, particularly if it related to chemistry since the latter was generally conceded to be a German science, and such things did not need to be attested to by one hundred famous professors.

This question is not an academic one merely, and if it involved only the professional pride of our chemists, it would not merit a moment's consideration. Our too ready acceptance of such notions regarding the chemical industry has had, and is still having, a number of vicious consequences. As a clever trick of trade such claims have made millions of dollars for the German chemical interests, naturally at the expense of our own industries. We have not generally recognized until quite recently that the success of certain branches of chemical industry is vital to military preparedness, owing to the extreme importance of toxic gases, explosives such as picric acid, T.N.T., tetra-nitro aniline, guncotton and so on. But so widespread and deep seated is this fallacy in question that it has affected the morale of the Allied troops since toxic gases have come to play such a large part in the fighting. The belief has been quite common among the troops at the front that the poisons employed by the Germans are much more highly poisonous than anything which the chemists of the Allied countries could produce.

Let us take a glance at the facts in the case although it may be difficult in these times to analyze such matters with judicial temper. Prior to 1914 I exchanged views with the economist quoted at the beginning of this article and he proposed a number of questions which will serve our present purpose admirably.

First, it was submitted that the Germans had been chiefly responsible for the development of chemistry as a science. Let us see if they " had developed the science of chemistry for decades before it was important in any other country."

We may call upon a German witness in the person of Professor Doctor (and probably Obergeheimregierungsrat) Ernst von Meyer, who has written an excellent history of chemistry. All that space permits me to say here is that one may search the pages of this book almost in vain for a German name in the period during which the foundations of the science were being laid. We find men of genius in every other important country of that time. From the time of Robert Boyle to the great Swedish genius Berzelius, we find two names; Philippus Aureolus Paracelsus Theophrastus Boombastus Eremit von Hohenheim, otherwise known simply as Paracelsus, whom Erasmus selected to elevate the science of chemistry from the degradations of alchemy, but who through lack of character, failed to reach attainments of a higher order than those of a common quack; and Stahl, whose so-called discovery of phlogiston retarded the march of progress for about two hundred years. These are the German contributions to the origins of chemistry.

For genuine genius and brilliancy, one must look elsewhere than the land of " damned Professors," as Bismarck styled them. None of the really great discoveries in chemistry and none of its fundamental laws and generalizations have been made by Germans. We owe our fundamental gas laws to Boyle, Gay-Lussac, Van der Waals, Joule, Thomson and Graham; the atomic theory and the laws of definite and multiple combining proportions to John Dalton. Lavoisier gave us the law of conservation of mass, which was painstakingly tested about a century later by the German Landolt, who could find nothing the matter with it, although it was shown later that his experimental methods were too crude to detect the atomic disintegrations which occur continually, as we now know, in radio-active substances. The Italians Avogadro and Cannizzaro made important contributions to Dalton's theory and Dulong and Petit gave us the law of atomic heats. The law of mass action, one of the most important principles in chemistry, we owe to the Hollanders Guldberg and Waage, and the laws dealing with heterogeneous systems were formulated by an American, Willard Gibbs. Gibbs' principles were interpreted from their original severely mathematical forms by Roozeboom and first practically applied to the Stassfurt salts by Van't Hoff, both Hollanders. Special isomerism was discovered by Pasteur and its later development was due chiefly to Van't Hoff and Le Bel. Van't Hoff first formulated the laws of osmotic pressure and Faraday's researches gave us the law of electrochemical action which bears his name, but the great clarifying theory which correlated these and many other principles was the theory of electrolytic dissociation, formulated by Svante Arrhenius of Sweden. The intimate relationship between the atomic weights and the properties of the chemical elements was first shown by the Russian Mendelejeff and this relationship has been put into most perfect form by the brilliant young Mosely, killed at Gallipoli.

It might have been said that the Germans had not yet reached their stride, that this earlier period was a colonizing period, so to speak. But we find that the whole great mass of work in radio-activity, the newest branch of science, part chemistry and part physics, has been done almost entirely in France, England and Canada. The brilliancy and audacity of conception and the extreme delicacy and accuracy of experimentation with which the problems of radioactive matter have been solved certainly never have been surpassed in the history of scientific research. This research has been done mainly by the Curies, Becquerel, C. T. R. Wilson, Ramsay, Rutherford and Soddy—not a German among them.

The Germans, however, have done a great mass of work and for this they most assuredly deserve our thanks. Van't

Hoff once said that he was very glad that there were people in the world who would do all the little things which had to be done. In other words, to phrase it tersely, the Germans have been most assiduously laying brick in chemical science. But the architects were not German and the cornerstone ceremonies have not been held in the Central Empires.

Another question of interest was whether or not the Germans have been foremost in applying chemistry to industry. That an affirmative answer is frequently given to this question is due to the common error of mistaking the dye industry for the whole chemical industry in general. This particular industry has tinted our notion of the entire matter and has attracted attention like a Brazilian morpho. The dye industry has had an amount of publicity out of all proportion to its importance and while chemists of nearly every nationality have had a hand in it, from Sir William Perkin, the discoverer of the first coal tar dyes, to the present, let us, for the sake of brevity, concede the whole thing to the Germans, Easter egg dyes, microscope stains, red feathers, pink ribbons and all.

One difficulty in answering this question definitely and quantitatively consists in the fact that there is no commonly accepted definition of just what a chemical industry is. In England chemistry is popularly associated with pharmacy and the term chemist usually means an apothecary. Nowadays any industry may be considered as a chemical industry which brings about fundamental changes in the nature of the raw materials of manufacture or requires chemical research and control for its success. But if we take the classification of the German or United States Government customs schedules as to what constitute products of chemical industry, we find that, for the years just before the war, both the tonnage and money value of such products exchanged by the two countries show a comfortable balance in our favor.

Most countries have certain specialties of manufacture and for reasons which usually are not far to seek. Germany enjoys a rich deposit of potash salts. Nature put it there and it required a Hollander, Van't Hoff, to show how to purify and resolve the salt mixture into its more and less valuable components. Nevertheless the Germans profit by the industry. We possess large deposits of phosphate rock which is manufactured for use by sulphuric acid and exported to Germany, but I have never heard an American seek to prove his cultural or technical excellence by talking about our phosphate rock. Having large petroleum fields we export immense quantities of petroleum products, the chemical refining of which has been the work of American chemists. And so it is with Colorado carnotite ore from which we get radium and uranium salts, Canadian cobalt and nickel, the nitrate in Chile and a multitude of other things. Cheap and abundant natural gas, a curiosity in Germany, gave us cheap glass and built up a huge industry. Why boast of a glass eye industry when we have made thousands of tons of plate glass, cut glass and hundreds of other articles for half the world? Why bother with a wooden toy industry to compete with Nuremberg when we were making thousands of tons of the best spruce, poplar and birch paper pulp by the sulphite or soda processes, not to speak of enormous quantities of wood alcohol, acetic acid and acetone from other woods and finally alcohol from the mill waste? Abundant water power, coupled with the abilities of Americans like C. M. Hall and Edward Acheson, has resulted in a series of new electrochemical industries such as the manufacture of aluminum, artificial graphite, carborundum, calcium carbide and many other products. Germany being practically without cheap hydroelectric power can hardly hope to compete in the electrochemical industries with countries where it is abundant, such as in the United States and Canada.

The manufacture of Portland cement was developed mainly in England, but cheap fuel oil in America resulted in the invention of the rotary kiln, which, in turn, made possible the typically American plants producing a thousand or more barrels of cement a day. Another American invention, the use of very finely pulverized coal, made the rotary kiln for cement manufacture available to Germany. But I do not wish to convey the idea that we have been content merely to utilize our own natural resources. These instances are cited simply to show that many of the specialized chemical industries owe their origin and development to some local circumstance, or natural advantage. The Germans have specialized in organic chemistry, yet we can by no means concede this branch of the science wholly to them. Two of the greatest advances in organic chemistry in recent years were the discoveries of Frenchmen. The catalytic addition of hydrogen to what are called chemically unsaturated substances, which has resulted in the new industry of converting liquid fats into solid fats, of enhanced value for soap and culinary purposes, and which has been of great scientific value in research, was the discovery of Sabatier and Senderens. The most fruitful method of synthesis in organic chemistry, of incalculable value in research, was the use of organic compounds of magnesium, discovered by Victor Grignard. Another discovery, of considerable industrial importance, was that of the artificial resins, similar to amber, made by Baekeland, a Belgian.

Two things have largely assisted in the perpetuation of the German chemical myth, for myth it is as truly as that of the famous dwarf who ground salt from his little mill to make the ocean salt.

In the first place they have written good text books and splendid compilations on various subjects. Our libraries are filled with German handbooks, encyclopedias and lexicons, usually excellent and very useful. Some of these books represent a stupendous amount of work, and work of such kind that to one of creative genius it would be horrible drudgery. After all such work may be considered as mere bricklaying. To borrow an illustration outside of chemistry, try to imagine a creative genius, such as Shakespeare, compiling a Latin dictionary. However, we should certainly thank them for their patient, diligent bricklaying, even though their carelessness in fairly crediting the work done in other countries has been notorious.

Another factor in keeping the myth alive has been the fact that German universities were the first to offer systematic instruction in chemistry. The earlier German chemists nearly all received their instruction and training in chemistry outside of Germany from such men as Berzelius, Berthollet, Gay-Lussac, Dumas, Davy and Faraday. In their day these famous old pioneers of the science selected a few assistants and together they gave their time solely to research. When such men as Liebig and Wöhler returned to Germany they developed true to type and adapted the German custom of doing things by company and battalion to the teaching of chemistry, and they organized lectures and conducted laboratory work by classes. The influx of students from other countries was encouraged and there was a time when an American desiring to specialize in chemistry found the facilities for pursuing such study much better in Germany than in his own country. But that time is long past. Most German universities cling pretty close to the standard of the old organic laboratory when a few dollars' worth of glassware would suffice.

To attempt to give, even in outline, an accurate idea of how matters now stand as regards current contributions to industrial and theoretical chemistry would require a volume of formidable dimensions. It has recently been determined that three hundred and fifty-five American firms maintain research laboratories and many of our great universities have set aside separate buildings to be devoted exclusively to research. These research laboratories were a constant source of amazement to several German chemists of my acquaintance who visited this country at the time of the last International Congress of Applied Chemistry in 1912. Very curiously a certain line of research will sometimes develop in a certain country and persist for years. Thus probably the most accurate work in determining atomic weights, which has been done since the work of the Belgian, Stas, has been done in this country by Morley, Noyes, Richards, Baxter and others. But work of the greatest value is beginning to appear from the farthest corners of the world. Research papers from Calcutta, Sydney and Tokio are appearing with increasing frequency. Australia and the South African Union have made greater contributions in metallurgy, at least as measured by economic importance, than has the Harz mountains since the Hexentanzplatz was peopled with its flying witches. For example, the well-known cyanide process of gold extraction was developed in South Africa by McArthur and Forrest and has added enough gold to the world's supply of this metal to buy the Harz mountains several times over.

We expect that when middle Europe passes from under the Prussian eclipse a number of men of scientific genius may come to light. It would be contrary to the laws of Nature not to find a really clever German now and then, as every species produces, at rare intervals, what the biologist calls a sport. We have conceded that they have done very well in certain branches of organic chemistry, but chemistry can be monopolized by no nation so long as the distribution of brains and the chemical elements remain as they are.

Benjamin T. Brooks.